An Attempt to account for the CHANGE of CLIMATE, which has been obſerved in the Middle Colonies in North-America.

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IT is generally remarked by people who have reſided long in Pennſylvania and the neighbouring Colonies, that within the laſt forty or fifty years there has been a very obſervable Change of Climate, that our winters are not ſo intenſely cold, nor our ſummers ſo diſagreeably warm as they have been.

THAT we may be enabled to account for theſe phœnomena it will be neceſſary to take a tranſient view of the general cauſe of winds, and the remarkable difference of heat and cold, that is obſerved in different countries under the ſame parallels.

THO' the Sun is doubtleſs the general ſource of heat, yet we obſerve that countries are not heated in proportion to their diſtance from the Sun, nor even in proportion to their diſtance from the Equator. The inhabitants of the Polar Circles are hardly a perceivable diſtance, not a twenty-thouſandth part farther from the Sun, than thoſe between the Tropics, and yet the former are chilled with perpetual cold, while the others are ſcorched with conſtant heat.

WHEN the rays of the Sun ſtrike the Earth in a perpendicular direction, they will be reflected in the ſame direction on the particles of air through which they have paſſed, and thus increaſe their heat; a greater number of direct rays will alſo ſtrike the Earth in any given ſpace, than when they fall obliquely; therefore, the nearer the direction of the Sun's rays is to a perpendicular with the ſurface of the Earth, the greater cæteris paribus will the heat be. Hence, countries ſhould be colder the nearer they are to the Poles. But,

WE obſerve that the air may be heated to a very different degree in different countries, which are in the ſame latitude.

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according as they abound in rough mountains, fertile plains, or ſandy deſarts; as they are ſurrounded by land or by ſea, or according to the different wind, which prevail in thoſe countries. The temperature of Pennſylvania is very different from that of Portugal; and the temperature of England is different from that of Saxony, on the neighbouring continent, though they be under the ſame parallels. In order then that we may be enabled to form an eſtimate of the heat of any country, we muſt not only conſider the latitude of the place, but alſo the face and ſituation of the country, and the winds which generally prevail there, if any of theſe ſhould alter, the climate muſt alſo be changed. The face of a country may be altered by cultivation, and a tranſient view of the general cauſe of winds will convince us, that their courſe may alſo be changed.

It is generally believed that moſt winds are occaſioned by the heat of the Sun. Were the Sun to ſtand ſtill over any particular part of the ſurface of the earth, the wind would conſtantly blow to that place from all directions. For the air in that part being rarified by the heat of the Sun, would be expanded and thus become lighter, whence it would aſcend, and the heavier air in the neighbouring parts would ruſh in, to occupy its place; this too being heated both by the Sun's rays and by the warm ſurface of the Earth, would inſtantly aſcend to give place to that which was colder. But as the Sun moves, or ſeems to move, between the Tropics, from Eaſt to Weſt, there ſhould be a conſtant current of air ſeting towoards the Sun from the North, South, and Eaſtward, while the current, which would alſo come from the Weſt, is prevented or turned back by the Sun, who moves with great rapidity on the oppoſite direction. The current coming from the North and South, falls in with that from the Eaſtward, and is preſently bent in the ſame direction. This conſtitutes what ſeamen call a *Trade Wind*; ſuch is found in the Atlantic, and in the Great South Sea.

Were the ſurface of the Earth homogeneous, were it all covered with water, or all ſmooth dry land, the eaſterly winds would always prevail quite round the Globe to ſome diſtance beyond the Tropics. But the waters along the Equator are divided

divided by two or three conſiderable portions of land, which retain the heat in a different manner from the water, and reflect the Sun's rays in very different proportions, ſo that they not only ſtop the eaſterly current of air, but often change it to the oppoſite direction. For along the weſterly coaſt of Africa, and South-America, the winds commonly blow from the Weſt. That is to ſay, they blow from a cold ſurface to that which is warmer, they blow from the ſea in upon the land. For,

In warm countries, or in the warm ſeaſon of any country, the ſurface of the land is warmer than the ſurface of the water.

In cold ſeaſons of temperate countries, the ſurface of the land is colder than the ſurface of the water.

The ſurface of the Earth being immovably expoſed to the Sun, receives and retains the heat, and grows warmer by every adventitious ray; ſo that a hard ſmooth ſurface will ſometimes become intolerable to the touch, but the heat does not ſink deep, except in a conſiderable progreſs of time.

The ſurface of the Sea is not ſoon heated, for the particles which are uppermoſt this hour, will preſently be overwhelmed by thoſe which are colder, and they, by others in ſucceſſion; whence it happens, that though the ſurface of the Sea will not become ſo warm by a ſummer's heat as the ſurface of the Earth, in the ſame climate, yet the heat will penetrate deeper, and be longer retained.

Let us tranſfer theſe trite and general reaſonings to the ſituation of our Middle Colonies, with reſpect to Land and Water. Our coaſt runs nearly from North-Eaſt to the South-Weſt. ſo that if the land ſhould at any time be colder than the ſea, and a current of cold air ſhould ſet towards the ſea, it muſt paſs from the North-Weſt to the South Eaſt: But ſuch winds we find generally take place during our winter ſeaſon. For the Atlantic, to the South-Eaſtward, is greatly heated during the ſummer ſeaſon, and will not ſoon looſe that heat when the Sun goes to the Southward in the winter; add to this,

this, a very notable circumſtance, which is, that our coaſt is conſtantly waſhed by a current of warm water, which being driven to the Weſt by the eaſterly trade winds near the Equator, is checked in the Gulph of Mexico, and obliged to eſcape to the North-Eaſtward, to give place to the ſucceeding current. But the ſurface of theſe colonies ſoon grows cold in the abſence of the Sun. Hence violent torrents of winds paſs towards the Atlantic during the winter ſeaſon; the colder the air is over the continent, the more violent will thoſe North-Weſters be.

Can we diſcover any change of circumſtances, which might reduce the violence of thoſe North-Weſters, or remove them entirely? It is very obvious that hard ſmooth ſurfaces reflect heat better than thoſe which are rough and unequal; the ſurface of a looking-glaſs, or any poliſhed metal, will reflect more light and heat, than the rough ſurface of a board. In the ſame manner we obſerve, that rocks and ſmooth beds of ſand reflect more heat, than a ſoft broken ſurface of clay. A clear ſmooth field alſo reflects more heat, than the ſame ſpace would have done, when it was covered with buſhes and trees.

If the ſurface of this continent were ſo clear and ſmooth, that it would reflect ſo much heat as might warm the incumbent atmoſphere, equal to the degree of heat produced by the neighbouring Antlantic, an equilibrium would be reſtored, and we ſhould have no ſtated North-Weſt Winds: But we have already made conſiderable approaches to this very period, ſeveral Members of the Society muſt have obſerved, that our North Weſt Winds, during the winter ſeaſon, are leſs frequent, leſs violent, and of ſhorter continuance, than formerly they were. Seamen, who are deeply intereſted in this ſubject inform us, that in the winter ſeaſon they have been beating off our coaſt three, four, or five weeks, not able to put in, by reaſon of the North-Weſters; they are now ſeldom kept off twice that number of days. It is alſo agreed, that the hardneſs of our froſts, the quantity and continuance of our ſnows, are very unequal now, to what they have been, ſince the ſettlement of this Province.

It has been objected, that the ſmall alteration which the ſurface of a country undergoes in being cleared and cultivated, is not equal to producing ſuch conſiderable changes of climate, as has been obſerved to take place in many parts of the world. I ſhall not ſay, that a change of climate may not ariſe from other cauſes than the one I have deſcribed. It is very certain, that the ſimple ſolution of water in air will produce cold, which may be increaſed by a ſolution of nitrous ſalt. There are ſundry other cauſes, from which the heat of the air may be increaſed or diminiſhed, yet I cannot recollect a ſingle inſtance of any remarkable change of climate, which may not be fairly deduced from the ſole cultivation of the country. The change which has happened in Italy, and ſome countries to the eaſtward, within the laſt ſeventeen Centuries, is thought to be a ſtrong objection to this general rule. It is ſaid, "that Italy was "better cultivated in the Auguſtine age than it is now; but "the climate is much more temperate now than it was at that "time. This ſeems to contradict the opinion, *that the cultiva-* "*tion of a country will render the air more temperate.*"

I shall conſider this obſervation the more attentively, becauſe I find it has been made by an ingenious Writer, of great Claſſical Erudition *.

It is not to be diſſembled that their winters in Italy were extremely cold about ſeventeen hundred years ago. Virgil has carefully deſcribed the manner in which cattle are to be ſheltered in the winter, leſt they ſhould be deſtroyed by the froſt and ſnow; he alſo ſpeaks of wine being frozen in the caſks, and ſeveral other proofs of ſuch extreme cold, as would ſurprize us in this Province. Though it is alſo clear, that the Italians are now as great ſtrangers to cold and froſt, as thoſe of Georgia or South-Carolina. To account for this remarkable change, we muſt go beyond the narrow limits of Italy; we muſt traverſe the face of Hungary, Poland and Germany, thoſe vaſt regions to the northward of Rome. The Germans have certainly made immenſe progreſs in population and agriculture, ſince Julius Cæſar with a few legions overran that country; for notwithſtanding the elegance with which Cæſar deſcribes his victories, he certainly had to contend with a

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* See Philoſophical Tranſaction, vol. 58.

ſett of barbarians and ſavages, whoſe country was rude and uncultivated as their minds. The general face of thoſe kingdoms was covered with wild extenſive forreſts, a few of which remain to this day. The ſmall ſcattered tribes who occupied them, had done very little towards the perfection of agriculture. From theſe uncultivated deſarts piercing North-Winds uſed to deſcend in torrents on the ſhivering Italian, though his own little common wealth were finely cultivated. No perſon need be informed how numerous the Nations are, who now inhabit Hungary, Poland, and Germany, or how generally thoſe regions are now cultivated, even to the very edge of the Baltic and German Ocean, ſo that if the cold is greatly moderated in Germany, and the adjacent Northern States, which I believe is generally allowed, we may eaſily perceive how it ſhould be moderated to a much greater degree in Italy, which being in a low latitude was only annoyed by the cold winds from the Northern Kingdoms. For the air was at that time ſo cold over thoſe uncultivated regions, that it could effectually deſtroy the balance in the warmer atmoſphere of Italy, which at preſent is not the caſe.

As we might have conjectured from eſtabliſhed principles of Philoſophy, that clearing and ſmoothing the face of a country, would promote the heat of the atmoſphere, and in many caſes would prevent or mitigate thoſe winter blaſts, which are the general origin of cold, whence the winters muſt become more temperate, and as facts appear to ſupport and confirm our reaſoning on this ſubject, we may rationally conclude, that in a ſeries of years, when the virtuous induſtry of poſterity ſhall have cultivated the interior part of this country, we ſhall ſeldom be viſited by froſts or ſnows, but may enjoy ſuch a temperature in the midſt of winter, as ſhall hardly deſtroy the moſt tender plants.

PERHAPS it may be apprehended, that as clearing the country, will mitigate the cold of our winters, it will alſo increaſe the heat of our ſummers; but I apprehend, that on a careful attention to this ſubject we ſhall find, that the ſame cauſe will in thoſe ſeaſons appear to produce different effects, and that inſtead of more heat, we ſhall preſently have leſs in ſummer than uſual.

It is well known, that during the greateſt ſummer heats of this or any other country, the extraordinary heat of the Atmoſphere does not riſe to any conſiderable height. In the upper regions it is perpetually cold, both becauſe the air in thoſe parts is too far from the Earth, to be warmed by the heat of its ſurface, and becauſe the air in thoſe regions not being preſſed by ſuch a weight of incumbent Atmoſphere is too rare to be ſuſceptible of a great degree of heat; for the heat of the air, as of every other body, that is warmed by the Sun, depends not only upon the ſimple action of the particles of light upon thoſe of the air, but alſo upon the mutual action of the particles of air upon one another, which, by their elaſticity, propagate or continue that motion, called heat, which was originally excited by the Sun's rays. Therefore, the rarer the Atmoſphere is, the leſs heat will be produced therein by the Sun, & vice verſa. Hence we obſerve, that in the warmeſt countries the tops of mountains are always covered with ſnow. Whoever will carry a Thermometer on a very warm day to the top of an high ſteeple, will find that the Mercury immediately falls ſeveral degrees, and riſes again as he deſcends. From this it is obvious that nothing is wanting in the midſt of ſummer to render the country agreeably cool, but a proper mixture of the cold air which is above, with the warm air below. This would be effected by any cauſe that might increaſe our ſummer winds. For though the ſimple motion of the air does not by any means produce cold, yet, moderate blaſts will naturally introduce a colder Atmoſphere, eſpecially when they paſs over hills or any unequal ſurface, by which the equilibrium of the Atmoſphere is deſtroyed, the cold air always tending towards the ſurface. Hence a ſummer's guſt is generally attended by a ſudden change in the temperature of the air. Tall timber greatly impedes the circulation of the air, for it retards the motion of that part which is near the ſurface, and which, from its denſity and ſituation being moſt heated, becomes the general origin of ſuch agitations as take place in the upper regions. We ſhall often find it extremely ſultry and warm in a ſmall field, ſurrounded by tall woods, when no ſuch inconveniency is is perceived on an extenſive clear plain in the neighbourhood. From theſe particulars we may conclude, that when this country ſhall be diverſified, as it muſt be in a

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ſeries of years, by vaſt tracts of clear land, interſected here and there by great ridges of uncultivated mountains, a much greater degree of heat being reflectedby the plains than from the neighbouring mountains, and an eaſy circulation of air produced on the plains. Our land winds in ſummer, to ſay nothing of thoſe which come from the ſea, or from the lakes, muſt certainly be much freſher and more frequent than they now are, and conſequently our ſummer heats be more temperate.

A CONSIDERABLE change in the the temperature of our ſeaſons may doubtleſs effect a change in the produce of our lands. Temperate ſeaſons muſt be friendly to meadows and paſturage, provided we continue to get regular ſupplies of rain; but of this, there is ſome reaſon to doubt, unleſs our mountains, with which this country happily abounds, ſhould befriend us greatly. The decreaſe of our froſts and ſnows in winter, muſt for many years prove injurious to our wheat and winter's grain. The viciſſitudes of freezing and thawing have already become ſo frequent, that it is high time for the farmer to provide ſome remedy, whereby he may prevent his wheat from being thrown out in the winter ſeaſon.

A CONSIDERABLE change in the temperature of our ſeaſons, may one day oblige the Tobacco Planter to migrate towards the Catolinas and Florida, which will be the natural retreat of that Plant, when the ſeaſons admoniſh the Virginian to cultivate wheat and Indian corn. The tender Vine, which would now be deſtroyed by our winter's froſt, in a few years ſhall ſupply the North-American with every ſpecies of wine. Poſterity will doubtleſs tranſplant the ſeveral odoriferous, aromatic, and medicinal plants of the eaſtern countries, which muſt flouriſh in one or another part of North-America, where they will find a climate and ſoil favourable to their growth, as that of their native country.

EVERY friend to humanity muſt rejoice more in the pleaſing proſpect of the advantages we may gain in point of Health, from the cultivation of this country, than from all the additional luxuries we may enjoy, though both the Indies were

brought to our doors. The ſalutary effects which have reſulted from cleanſing and paving the ſtreets of Philadelphia, are obvious to every inhabitant. For cauſes ſomewhat ſimilar to theſe, the general improvement of the colonies have already produced very deſirable effects. While the face of this country was clad with woods, and every valley afforded a ſwamp or ſtagnant marſh, by a copious perſpiration through the leaves of trees or plants, and a general exhalation from the ſurface of ponds and marſhes, the air was conſtantly charged with a groſs putreſcent fluid. Hence a ſeries of irregular, nervous, bilious, remitting and intermitting fevers, which for many years have maintained a fatal reign through many parts of this country, but are now evidently on the decline. Pleuritic and other inflammatory fevers, with the ſeveral diſeaſes of cold ſeaſons, are alſo obſerved to remit their violence, as our winters grow more temperate.

Since the cultivation of the colonies, and the conſequent change of climate, has ſuch effects on the diſeaſes of the human body, and muſt continue to produce ſuch remarkable changes in their appearance, it is certainly the duty of every Phyſician, to be careful to trace the hiſtory of every diſeaſe, obſerve the ſeveral changes they undergo, and mark, with a jealous attention, the riſe of every new diſeaſe, which may appear on the decline of others, that ſo he may be enabled to bring effectual and ſeaſonable relief to ſuch perſons, as may be committed to his care.